in suspension in water may be coalesced by salt or lime solutions but the change is not sufficient to overcome the colloidal state as in the case of the coalescence of the fog particles into liquid water, and on removing the coagulating agency the colloidal matter may again be put in suspension.

As before stated the only means yet discovered to change the colloidal nature of the soil colloids is through an enormous expenditure of energy in heating the material to 900° or 1000° to completely drive off the water of hydration and leave the material an amorphous mass lacking entirely colloidal properties. This is too expensive a method to be used in agriculture or in road construction to particularly affect the plasticity of the wet clays. The problem before the soil chemist and the road engineer is to bring about a change in the internal energy of the soil colloid so as to break up the complex hydrates and permit the atoms or molecules of silicon, aluminum, and iron to form a crystalline or an amorphous solid and thus make the extremely plastic clays less plastic and more friable.

The molecular weights of colloids determined from diffusion or from freezing point are very high, reaching the figure 25,000 for starch. The question arises as to whether this figure is applicable to the molecule of the anhydrous colloid or to the colloidal molecule associated with the extremely complex system of hydrates that have attached themselves to the molecule of the colloidal substance. Numerous cases have been reported where zeolites have formed after the percolation of soil moisture through exceedingly small openings in rocks and building stones. The question arises as to whether sufficient force can be exerted to force a colloidal solution through openings too small to carry the associated water of hydration, and whether under these conditions, like the stirring of a supersaturated solution, the molecules of the colloid could be brought sufficiently close to combine into a crystalline or amorphous solid.

This is of theoretical interest only. The practical problem seems to be to find some cheap method of breaking up the complex hydrates to give the atoms of silicon, aluminum and iron, or the hydrated molecules of the silicate an opportunity to combine in a solid form.

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## WHEN WILL THE TEACHING OF CHEMISTRY BECOME A SCIENCE?[1]

When will the teaching of chemistry become a science? Before answering this question, let us ask another question. When did chemistry become a science? Chemistry became a science when men found that there were different elements; that these elements had different properties; that they could be changed into different forms; that they would react with one another and give different products and that in all these interactions and transformations there was no loss or gain of mass. These are a few of the fundamental conceptions that were necessary before chemistry could become a science.

The teaching of chemistry will become a science when we as teachers recognize that every student is possessed with certain original tendencies with which we are to work just as the chemist works with the elements. These original tendencies are subject to transformations and interactions, but they can not be destroyed any more than an element. The law of the conservation of mass holds. Sometimes the psychologist speaks of an original tendency being eliminated. He means by this that the tendency has been so modified that you can not recognize it. The chemist would say that it had suffered a chemical change or had been changed into an allotropic form.

For the benefit of those people who studied psychology some years ago, I might say that a few of these original tendencies are curiosity, manipulation, mastery, fear, sex instinct, hoarding, ownership, etc. These are the rocks upon which we build our chemical

[1] Read before the Section of Chemical Education, American Chemical Society, New York, September 8, 1921.

structure, and hence in our teaching of chemistry, we must hew these rocks into shape by the use of chemical tools. You may ask what do you mean by this and how may it be done? To illustrate, I will take the first tendency which I mentioned, namely, curiosity.

There is not a normal boy or girl who has not an original tendency to want to know the reason or wherefore of almost everything with which they come in contact. As they begin their school days this tendency is gradually transformed into a submissive tendency by the teacher's desire to not wish to be bothered with so many questions, and when the student reaches the chemistry department, we generally put the finished transformation touch to it, and hence we have destroyed the properties of one of the most energizing elements in the promotion of chemical education.

If we find that a student, when he comes to our chemistry department, has had this tendency partly transformed, it should be our business as teachers of chemistry to bring back or revert this original tendency to its pure condition. Now, you ask me how this may be done. I can tell you how it can not be done. It will never be done by telling the student all the results or letting him read all the results before he goes to the laboratory, that is, by letting him go to the laboratory with the feeling that his experiments are only to illustrate the lecture or book. Such work is highly artificial and not only dulls the keen observations of the student, but absolutely tends to kill all curiosity. To be sure life is too short to find out everything in the laboratory, but what he can find out and has time to find out let him find out without telling him. What he does not have time to find out or can not find out, tell him in plain English. A few things found out for himself will stimulate and augment his curiosity, and put him in an appreciative attitude for results told him. Hence I say that we as chemists can develop this original tendency of curiosity by the proper handling of the laboratory end of chemistry. This must be put up in such a way as to arouse the student's curiosity. This may be done by putting all laboratory work in problem form and letting that problem be one that has not been explained over and over and over again in both lecture and book. You may call this a project in spite of the fact that we understand that a project is a piece of work carried out in its natural setting. The laboratory is a natural setting in the study of chemistry.

I feel that the project or problem method produces the most favorable conditions or situations for arousing and holding the original tendency of curiosity, and furthermore I am sure that this same feeling is shared by many others, and because of this fact I can not understand why it is not more generally used.

I am of the opinion that the entire chemistry course can be developed by the project method. Let the reading matter raise a problem or project, and then let this project be straightened out by a little elementary research. When he has solved his problem or project his book reads smoothly, and when he has solved all the projects in the book his book is complete, and it is not complete until he has. He must do his share before he can gain a full knowledge of his subject. Such a situation produces a normal curiosity, and at the same time there is a very noticeable improvement in his observations and powers of reasoning, both of which are so essential to a chemist.

The teaching of chemistry will become a science when chemistry teachers begin to seek for the situations or conditions that will properly develop all these original tendencies which are closely allied with chemistry. When, we, as chemists, have found the conditions or situations that produce certain results with the elements of chemistry, what do you do? You publish these results or come to such a meeting as this and give other chemists the benefit of your results. Why should you not do likewise when you have found the proper conditions for the development of these original tendencies?

I have mentioned one situation for the development of curiosity. I hope that next year someone else will give us a better situation for its development, and some other men will give us chemical situations for the development of some other original tendencies. When we get all these situations worked out from a chemical standpoint we can tell what situation to put up to get a certain response from a given original tendency just as the chemist knows that he will get a certain reaction from a given element when he subjects it to a certain situation or condition.

When we all have gone back to the student and begun to develop the teaching of chemistry on original tendencies, the teaching of chemistry will become a science, and nothing will hasten that day more than meeting together in an open forum as we have done this week. It is a pity that the teaching of chemistry is not recognized fully as a profession, but no one is at fault but ourselves. Let us become worthy of the profession by studying the teaching of chemistry in a scientific way, and then people will not hesitate to give the calling of teaching chemistry a proper place and the college professor a living wage.

Neil E. Gordon

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## SCIENTIFIC EVENTS

### EARL JEROME GRIMES

The executive committee of the Association of Virginia Biologists has adopted the following minute:

The executive committee of the Association of Virginia Biologists has heard with deep regret of the death of Earl Jerome Grimes, associate professor of biology in the College of William and Mary. Less than a month ago he was present in our fall meeting and contributed largely to its success. By his death the College of William and Mary has been deprived of a faithful and inspiring teacher; this association of a valued member and counselor; and the science of botany of a young disciple of great promise. To his family and to his college we wish to express our most heartfelt sympathy in their great loss.

This minute we instruct the secretary to spread on the records of the association, to have published in Science, and to communicate it to Mrs. Grimes and to the faculty of the College of William and Mary.

### ELECTRIC POWER MAPS

A map of New York State showing the location of the power stations and electrical transmission lines used by public utility companies has been published by the United States Geological Survey, Department of the Interior. It was originally planned to publish these maps as plates in water-supply papers, which were also to contain tabular information in regard to the equipment of the power stations and the chief characteristics of the transmission lines, but to avoid the expense and delay incident to the publication of such reports the maps will be issued separately and sold. The map of New York State is the first one to be published and may be bought for one dollar from the director of the United States Geological Survey at Washington. The base map used is the Geological Survey's map of the state, 64 inches long and 45 inches wide, scale 1:500,000. The map shows the location of the stations and primary transmission lines and bears a numbered list of the power companies, the numbers corresponding to numbers assigned to the stations on the map. Proof maps were first made and sections of them were sent to the companies for correction or revision. Similar maps of New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, Maine, New Jersey, Pennsylvania, Maryland and Delaware are in course of preparation. These maps will be valuable to those who are studying interconnection of power companies and to those who wish to establish manufacturing plants within reach of electric power—in fact, they will be useful to any one contemplating the use of power in any way.

### MEDALS OF THE ROYAL SOCIETY

At the anniversary meeting of the Royal Society on November 30, Professor Sherrington presented the medals (we quote from *Nature*) as follows: The Copley medal to